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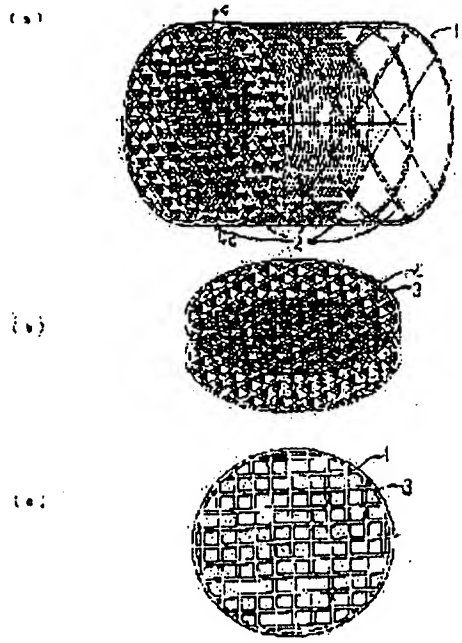
(54) HONEYCOMB CERAMIC STRUCTURE

(57)Abstract:

PURPOSE: To obtain a honeycomb ceramic structure having high thermal shock resistance, capable of being constituted in any dimension and in a large size by laminating honeycomb ceramic modules of a fixed shape in the axial direction of their open cells.

CONSTITUTION: This honeycomb ceramic structure 1 is constituted by laminating plural honeycomb ceramic modules 2 (cell walls 4) having fixed open cells 3 and fixed thickness in the axial direction of the open cells 3. The honeycomb ceramic modules 2 are generally a laminar or disklike shape. The honeycomb ceramic modules 2 have preferably ≥10cm longer diameter L in the cross direction of the open cells 3, ≥1mm thickness T in the axial direction of the open cells 3 and ≤0.5T/L. A layer material for shock absorption having open cells is preferably arranged between the honeycomb ceramic modules 2 and/or the end face of the honeycomb ceramic structure 1 so as to absorb at least one of mechanical and/or thermal stress.



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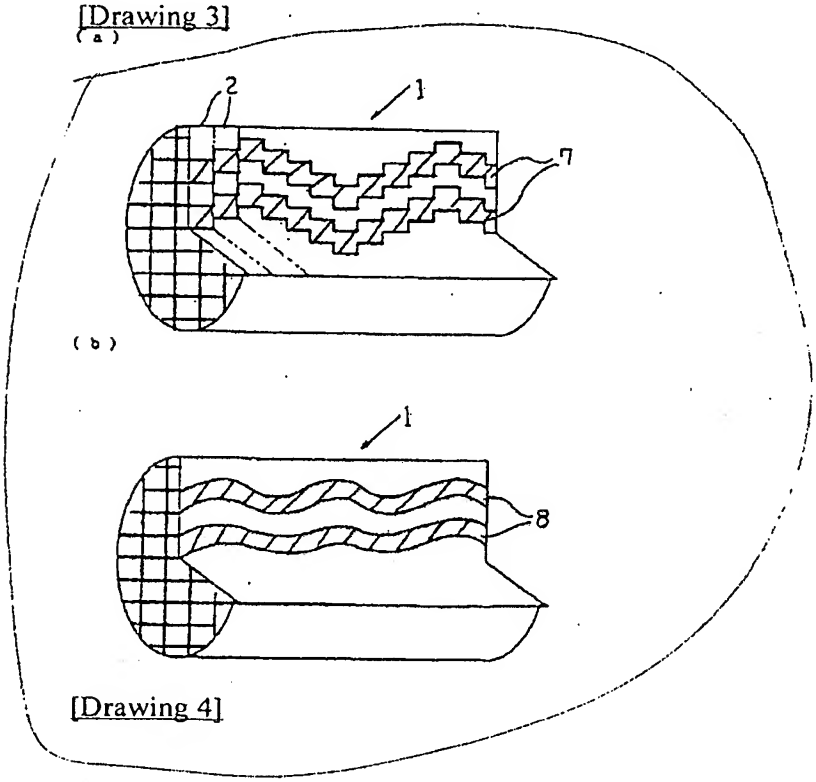
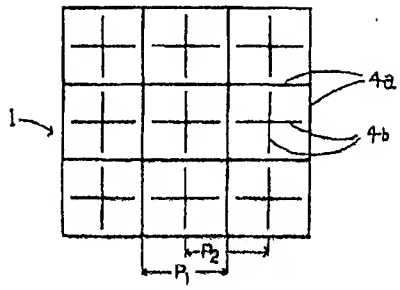
DRAWINGS

[Drawing 3]



[Drawing 4]

(a)



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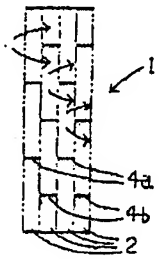
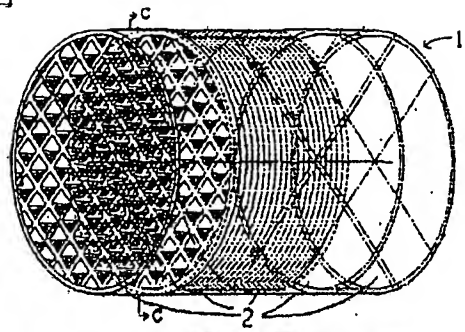


[Drawing 1]

(a)



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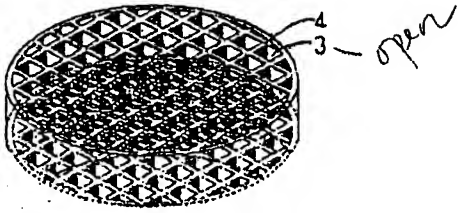

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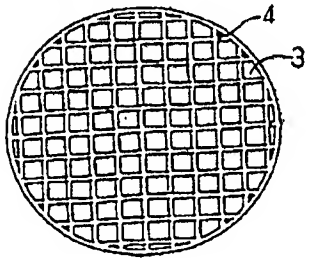
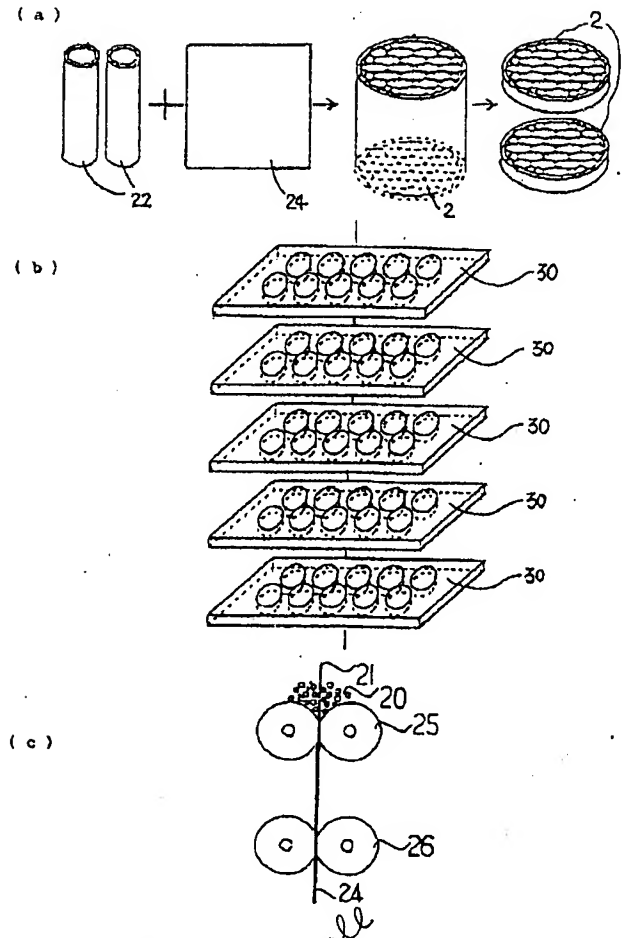
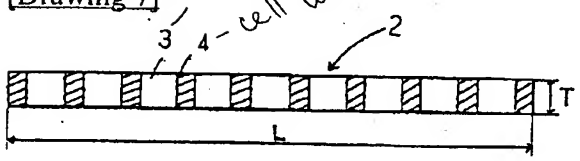


[Drawing 2]

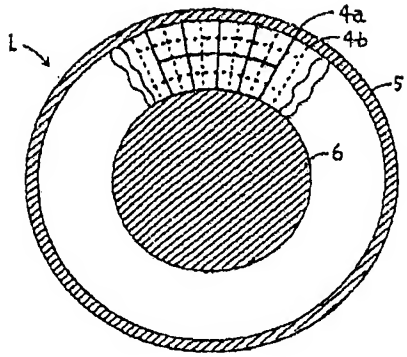


[Drawing 7]



[Drawing 5]

(a)



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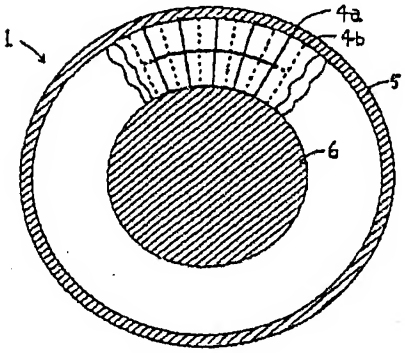
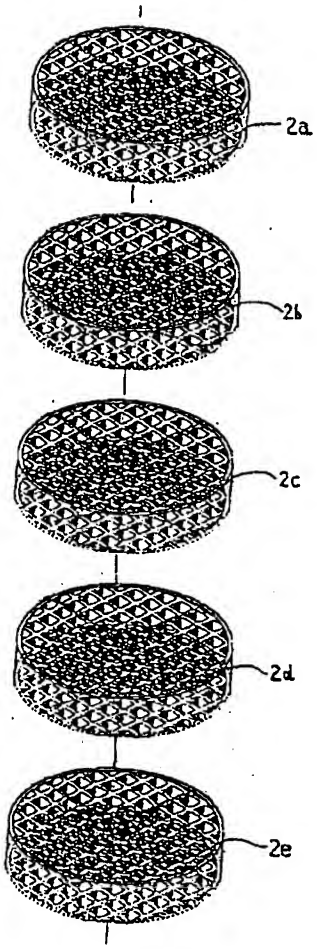


[Drawing 6]



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the honeycomb-like ceramic structure 1 of the example of this invention, and (a) shows the strabism transparency Fig. of the honeycomb-like ceramic structure 1, and especially the puncturing cel 3 the strabism transparency Fig. of a honeycomb-like ceramic module and whose (c of (b)) are the sectional views of the direction of c-c' of (a).
[Drawing 2] Drawing 2 shows the manufacture approach of the ceramic material sheet used as the honeycomb-like ceramic structure and its raw material, and the manufacture approach of the honeycomb-like ceramic structure according [the manufacture approach of the honeycomb-like ceramic structure according / (a) / to the pipe banding-together method and (b)] to a press-die omission method etc. and (c) are the manufacture approaches of the ceramic material sheet by roll diffusion bonding.
[Drawing 3] Drawing 3 is the strabism fragmentary sectional view of the honeycomb-like ceramic structure 1, (a) shows the three-dimensional structure of the puncturing cel 3 formed stair-like, and (b) shows the three-dimensional structure of the puncturing cel 3 formed spiral.
[Drawing 4] Drawing 4 shows typically the cell wall 4 of the tabular module 2 by which shifted the phase of a puncturing cel in the honeycomb-like ceramic structure 1, and the laminating was carried out, (a) is the top view of a cel puncturing side, (b) is a side elevation and the arrow head shows a part of flow of a fluid typically.
[Drawing 5] Drawing 5 is the top view of the cel puncturing side of the honeycomb-like ceramic structure 1, some cell walls of the module of the shape of a disk disk by which shifted the phase of the puncturing cel 4 and the laminating was carried out are shown, and, in (a), the module with which puncturing cel cross-section configurations differ, and (b) carry out the laminating of the module with the same puncturing cel cross-section configuration, respectively. The 1st step of all cell wall 4a shows some cell walls of the module of the shape of a disk disk by which shifted the phase of the real puncturing cel 4 and the laminating was carried out. A continuous line shows the 1st step of all cell wall 4a, and the dotted line shows cell wall 4b of the 2nd step of module.
[Drawing 6] as an example which made the honeycomb-like ceramic module 2 which is one example of this invention support the catalyst from which a function differs to drawing 6 and which carried out the laminating -- particulate (particulate matter) filter (PF) module 2a, heating element module 2b, and the catalyst support modules 2c, 2d, and 2e -- since -- the becoming exploded view of the honeycomb-like ceramic structure 1 is shown.
[Drawing 7] The sectional view of said honeycomb-like ceramic module 2 which is one example of this invention is shown in drawing 7 , and module die-length L of the direction of a cross section of the puncturing cel 3 and especially module thickness T of puncturing cel shaft orientations are shown in it.
[Description of Notations]
1 Honeycomb-like Ceramic Structure
2 Honeycomb-like Ceramic Module
3 Puncturing Cel
4 Cell Wall (Cel Frame)

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] About the honeycomb-like ceramic structure, especially this invention is excellent in a heat-resistant impact, and suitable for the use as catalyst support. It is the big features that there is little pressure loss, and there is little engine horsepower loss. Moreover, a structure top silencing effect is large and excellent also in the environmental side.
[0002]
[Description of the Prior Art] The honeycomb-like ceramic structure has a large specific surface area, and since a through fluid can be made to flow, the through tube has been used as the catalyst support for automobiles (exhaust gas purge), or chemical reaction catalyst support.
[0003] In the field of the catalyst support for automobiles as which the quality of the material with especially strong thermal shock resistance and an organization are required, by extrusion molding, crystal orientation of the cordierite was carried out and it was made into the honeycomb-like ceramic structure.
[0004] As the honeycomb-like ceramic structure and the manufacture approach, by JP,48-66112,A, concavo-convex processing of the monotonous ceramic sheet (ceramic material sheet) other than extrusion molding was carried out, and the concavo-convex sheet was made into the laminating or honeycomb [which involves in and calcinates and is equipped with a puncturing cel]-like ceramic structure in the hoop direction (direction where a cross section is parallel to the field which makes a honeycomb) of a cel (concave heights).
[0005] Moreover, similarly, by JP,48-66112,A, in the direction parallel to the field which accomplishes a honeycomb, the cross section involved the pipe of the shape of long tubing which forms a puncturing cel in plurality and a monotonous ceramic sheet (ceramic material sheet), calcinated it, and was considering as the honeycomb-like ceramic structure equipped with a puncturing cel.
[0006] In JP,57-179060,A, independent and the ceramic structure which makes mutually the hole which does not penetrate the structure and has a puncturing (free passage) cel according to this hole and the three-dimension network structure were manufactured with the rod from the both ends of said structure in the condition of having plasticity, in the porosity ceramic structure which has the three-dimension network structure which forms the internal free passage space of a large number which lead outside.
[0007]
[Problem(s) to be Solved by the Invention] However, in extrusion molding, the limitation was in the magnitude of the structure obtained. For example, in order for the fluidity of a molding material to fall and for extrusion molding to obtain the structure of a difficult and big diameter, structure thick to the shaft orientations of a puncturing cel had to be combined, and also had to enlarge metal mold. The outer diameter of 10-15cm was actually a limit.
[0008] Furthermore, the plant-and-equipment investment amount of money of extrusion-molding equipment was large, and the yield of a shaping product was bad and was holding the trouble that there were many raw material losses.

[0009] Moreover, at the time of use, the rapid temperature rise arose locally, the big temperature gradient at an exhaust gas inlet port and an outlet arose especially, and structure long (thick) to the shaft orientations of a puncturing cel had the thermal shock large at the time of starting, especially when using as for example, catalyst support for exhaust gas for automobiles. Therefore, the magnitude of the structure had a limit.
[0010] Moreover, it was difficult among the production process for a check, a crack, or destruction to tend to produce the structure of a major diameter or a major axis with thermal stress also at the time of ceramic sintering, and to manufacture the large-sized honeycomb-like ceramic structure further, with the limitation and compacting pressure of the self-hold force, in the honeycomb structure formation process in the condition of having predetermined plasticity, for the fall of the product yield by deformation by burning shrinkage big moreover.
[0011] Moreover, since the whole consisted of the one structure, the conventional honeycomb-like ceramic structure also as catalyst support is difficult for supporting a different catalyst, and needed complicated processes, such as masking partial for that purpose.
[0012] Especially the catalyst support for automobile exhaust needs to achieve the function (oxidation, reduction, and particle adsorption) in which properties differ. Therefore, if neither engine combustion conditions nor the temperature of catalyst support of 3 yuan (3 way) was moreover controlled to a precision, for example using the catalyst, the predetermined exhaust gas removal engine performance was not demonstrated. However, since the aforementioned conditions changed with the time of starting and a heavy load, or external atmospheric temperature, it was impossible under technical, spatial, time [predetermined], and predetermined cost restriction to have removed the harmful matter of all classes by all service conditions in practice. Although current does not stand especially about a Diesel engine and the exhaust gas purge for large-sized engines moreover as for the prospect of the technical solution, the solution has been a pressing technical problem on environmental preservation.
[0013] Let it be a technical problem for this invention to offer the honeycomb-like ceramic structure which is strong to a thermal shock, can constitute in the dimension of arbitration, and is made [1st] also on a large scale. It aims at considering as the application, for example, specifically offering a thing usable as exhaust gas catalyst support for catalyst support with high catalyst effectiveness, the catalyst support for chemical reactions, offgas treatment equipment, a bioreactor, a wastewater purge, the potable water purge, especially automobiles.
[0014] This invention makes it a technical problem to make it the 2nd equipped with two or more functions into the one structure.
[0015] This invention makes it a technical problem to offer the honeycomb-like ceramic structure calcinated from the puncturing cellular structure with 3rd high chemical reaction effectiveness or heat exchange effectiveness, such as catalytic reaction, or a raw material.
[0016] This invention makes it a technical problem to provide it with the structure of the honeycomb-like ceramic structure in which the improvement in the yield at the time of manufacture is possible at the time of honeycomb shaping and baking, so that defective generating of a crack, a check, etc. may decrease to the 4th. This invention makes it a technical problem 5th to also provide Diesel engines, such as a motor coach, a heavy-duty truck, a railroad, a generation of electrical energy, and a vessel, with the honeycomb-like ceramic structure for exhaust air especially applicable also to a large-sized engine to use for a purge.
[0017]
[Means for Solving the Problem] This invention is the honeycomb-like ceramic structure which carries out a laminating to the shaft orientations of a puncturing cel, arranges two or more said honeycomb-like ceramic modules of predetermined thickness, and changes, as at least one of the above-mentioned purpose and the technical problems is attained, it has a predetermined puncturing cel in the 1st view of this invention and the shaft orientations of plurality and a puncturing cel open a given thickness Mino honeycomb-like ceramic module for free passage (claim 1).
[0018] With a predetermined puncturing cel, the gestalt of the shaft orientations of a puncturing cel contains further the number of puncturing cels, the diameter of puncturing, the puncturing area per

direction area of a puncturing cel cross section, the die length of a cell wall and a cel or the ratio of area, and the thing from which three-dimensional gestalten, such as the shape of spiral, the letter of zigzag, stair-like, and a taper, differ.
[0019] The case where the laminating of the module with which thickness differs from a given thickness Mino module is carried out is included.
[0020]
[A suitable means] The 2nd suitable means is the honeycomb-like ceramic structure given in 1st means by which said honeycomb-like ceramic module is characterized by having the shape of tabular or a disk (claim 2).
[0021] It is the honeycomb-like ceramic structure large-sized [the 3rd suitable means] and thin, and the major axis L of the crossing direction of the puncturing cel of a honeycomb-like ceramic module is the honeycomb-like ceramic structure given in a means of 1st **** 2 by which thickness T of the shaft orientations of 10cm or more and a puncturing cel is characterized by T/L of 1mm or more, and a thickness / major-axis ratio being 0.5 or less (claim 3).
[0022] The 4th suitable means is the honeycomb-like ceramic structure other modules of whose are the honeycomb-like ceramic structures given in the means of either of the 1-3rd means which has a different module in the thickness of the shaft orientations of a modular puncturing cel, a modular outer diameter, the gestalt of a puncturing eel, etc. (claim 4).
[0023] the puncturing cel which the 5th suitable means opens for free passage -- abbreviation -- it is the honeycomb-like ceramic structure given in the 1-4th ones which are characterized by forming the spiral fluid channel of means (claim 5). abbreviation -- the case where passage is formed stair-like or in the shape of zigzag as it is spiral is included. moreover, the fluid which passes a puncturing cel open for free passage -- abbreviation -- the puncturing cel itself which is [that what is necessary is just to form spiral flow] not necessarily open for free passage -- abbreviation -- it does not need to be spiral.
[0024] the 6th suitable means -- a puncturing cel cross-section configuration -- a circle -- mutual -- the same honeycomb-like ceramic module -- a same axle top -- the hoop direction of a puncturing cel cross section -- rotation or the puncturing cel which carries out a laminating alternately and is open for free passage -- abbreviation -- it is the honeycomb-like ceramic structure given in the 1-5th ones which are characterized by forming the spiral fluid channel of means (claim 6).
[0025] The 7th suitable means is the honeycomb-like ceramic structure given in the 1-6th ones which are characterized by combining the layer material for impact absorptions with an inter module or a structure edge of means. The approaches of association are immersion, spraying, joining, welding, adhesion, baking, fitting, etc. Metals, such as the others and above-mentioned spring configuration, plate-like (stratified), or a block configuration, semimetals (silicon etc.), or an alloy is sufficient as impact-absorbing layer material (claim 7). [elastic members /, such as flat spring, a disk spring, coiled spring, and rubber, / usual]
[0026] It is the honeycomb-like ceramic structure given in the 1-7th ones which are characterized by the 8th suitable means making the structure of this invention catalyst support of means (claim 8).
[0027] The 9th suitable means is the honeycomb-like ceramic structure given in the 8th means characterized by supporting the catalyst for which a certain module differs from other modules, and demonstrating a different function (claim 9).
[0028] Each catalyst with which especially the 10th suitable means intercedes for oxidation, reduction, particle adsorption, and disintegration in the 9th means is the honeycomb-like ceramic structure given in the means of the 8th or 9 characterized by supporting at least one kind in the module which accomplishes the structure (claim 9). In addition, the module which is three-way catalyst support is also contained in the range of this means so that all three above-mentioned operations may be performed.
[0029] It is the honeycomb-like ceramic structure given in the 8-10th ones which are characterized by the 11th suitable means being the intense catalyst support for automobile exhaust of especially a thermal shock and a mechanical shock of means (claim 11).
[0030] It is the honeycomb-like ceramic structure given in the 1-11th ones which are characterized by the 12th suitable means consisting of quality of a ceramic from which a module differs of means (claim

12). For example, they are cordierite and an alumina. Furthermore, also of the same component, also when an organization differs from the crystal structure, it contains.
[0031] The 13th suitable means is the honeycomb-like ceramic structure given in the 1-12th ones which are characterized by the calcinated raw material of the structure using a ceramic and organic fiber as a principal component of means (claim 13). Organic fiber is burned down at the time of baking, and forms the predetermined porosity according to the class, gestalt, and baking conditions (the temperature, ambient atmosphere) of organic fiber.
[0032] It is the honeycomb-like ceramic structure given in the 1-13th ones which are characterized by calcinating the 14th suitable means from a ceramic raw material and the raw material which uses an inorganic fiber as a principal component of means (claim 14).
[0033] It is the honeycomb-like ceramic structure given in the 1-14th ones which are characterized by wrapping the 15th suitable means in the sheet-like object or tubular object with which the peripheral face of the honeycomb-like ceramic structure consists of a metal of means (claim 15). With a sheet-like object or a tubular object, even the sheet-like object or tubular object formed in the thickness of several cm order by winding a metal plate around a cylindrical shape at the honeycomb-like ceramic structure, for example from the thin film (sheet-like object) of the thickness below the micrometer formed of plating etc. is included. Furthermore, the case where the honeycomb-like ceramic structure is fitted in and held in a metallic tubular object (tube-like object) is included. Moreover, the tubular object which consists of a metal may be honeycomb structure. As a metallic material which forms the film or a tubular object, an ingredient with the heatproof of stainless steel etc. and corrosion resistance is desirable.
[0034]
[Function] The honeycomb-like ceramic structure of this invention is characterized [1st] by consisting of two or more honeycomb-like ceramic modules. Although they had the description which was [high-melting / a high degree of hardness,] excellent, ceramics were brittle materials in one side, and when there was especially a thermal shock (a rapid temperature change and heat gradient), and they were not the special quality of the material and the manufacture approach, they were difficult to use a ceramic.
[0035] For example, to the catalyst support for exhaust gas of an automobile, make cordierite with a very small coefficient of thermal expansion into extrusion molding, the orientation of the crystal orientation is made to make in the specific direction of a crystal to an one direction, and it is producing commercially.
[0036] However, there is a limit in enlargement of support, and the thinning (improvement in whenever [cel]) of a cell wall according to problems, such as a thermal shock by the temperature gradient of an exhaust gas inlet port and an outlet, and such catalyst support was not able to obtain sufficient mechanical strength, either. Moreover, when enlarging (structure especially huge to cel shaft orientations), the fluidity of a molding material and the crystal stacking tendency worsened, the thinning (improvement in whenever [cel]) of cel thickness also became causes, such as destructive deformation of the cel frame at the time of fluid aggravation and fluid unmolding of a molding material, also from a viewpoint of a production process further, and it was difficult to put in practical use (extrusion molding etc.).
[0037] Furthermore, the initial investment concerning a facility of an extruding press machine etc. is very large.
[0038] However, in order to improve catalyst effectiveness and the engine performance, it is necessary to extend the surface area of support by enlargement of catalyst support, or the thinning of cel thickness. Furthermore, for prevention of pollution, the emission control of an automobile becomes still severer and toughening of regulations of nitrogen oxides will be performed in toughening of regulations of the nitrogen oxides of the diesel rolling stock of small and a medium size, and Heisei 6 or 7 in Heisei 2 or 4 in recent years about a diesel weight vehicle, and the amount of inside and a weight gasoline truck bus, respectively. Each of these types of a car is large displacement, and in order to clear such regulation, development of the outstanding catalyst support serves as pressing need.
[0039] Enlargement and the thinning of cel thickness are possible for the honeycomb-like ceramic

structure of this invention, and it is the the best for contributing to prevention of pollution corresponding to the above-mentioned exhaust gas toughening of regulations as size catalyst support for automobiles.
[0040] That is, it is the honeycomb-like ceramic structure which has the structure which absorbs a thermal shock by carrying out a laminating to the shaft orientations of a puncturing cel, and consisting of said honeycomb-like ceramic modules of predetermined thickness.
[0041] Since the cel shaft-orientations distance of each module becomes short when the structure is made of not one but two or more modules, and the temperature gradient between tap holes decreases from the input to an exhaust gas flow direction in each module, the thermal shock of each module decreases. Moreover, a puncturing cel radial (the direction of a cross section) thermal shock also decreases.
[0042] The honeycomb-like ceramic structure which the major axis of such a crossing direction of a puncturing cel becomes from a module large and thin to the shaft orientations of a puncturing cel is formed in one like before, and compared with the structure (the major axis of the crossing direction of a puncturing cel is greatly thick to the shaft orientations of a puncturing cel) of this appearance, its temperature gradient per each module (whenever [thermal shock]) is small, and it does not almost have possibility by the thermal shock of therefore being divided distorted.
[0043] Moreover, since it was divided by the smallness of the structure holding power at the time of shaping, contraction distortion at the time of sintering, etc. and poor shaping / sintering, such as a check, occurred, the yield fell and utilization of a major axis fabricating and sintering the thick large and structure by one was not completed.
[0044] However, the structure which consists of a module of this invention is the structure which shows operation that can manufacture in the magnitude of arbitration according to the purpose of use and an application (especially the thickness of cel shaft orientations is selectable to arbitration), and the manufacture defect at the time of the above shaping or sintering does not occur, and it is strong to the thermal shock at the time of use.
[0045] If a module-structure object is used especially in the case of a major diameter and the structure thick as a whole, operation that the above-mentioned manufacture defect does not occur and it is strong to the thermal shock at the time of use is effective.
[0046] Although typically considered as the shape of profile tabular thru/or a disk, the module which forms the honeycomb-like ceramic structure of this invention is the honeycomb-like ceramic structure whose T/L of 0.3-1cm, or a thickness / major-axis ratio thickness T of the shaft orientations of 10cm or more or a puncturing cel is 0.5 or less preferably for the major axis L of the crossing direction of the puncturing cel of a honeycomb-like ceramic module. The manufacture defect at the time of the above shaping or sintering does not occur, and the structure which consists of such a module shows operation that it is strong to the thermal shock at the time of use.
[0047] Moreover, one of the modular desirable gestalten which makes the structure is the honeycomb-like ceramic structure whose T/L of 1mm or more, and a thickness / major-axis ratio thickness T of the shaft orientations of 10cm or more and a puncturing cel is 0.5 or less for the major axis L of the crossing direction of the puncturing cel of a honeycomb-like ceramic module.
[0048] Furthermore, T/L of the thickness / major-axis ratio of a honeycomb-like ceramic module of one of the modular more desirable gestalten which makes the structure is the honeycomb-like ceramic structure whose T/L is or less 1 / 50 to 1/100 still more preferably 1/10 or less.
[0049] Such by carrying out the laminating of many thin modules relatively, the structure of the magnitude which was not able to be conventionally realized by poor shaping / baking can be formed. Moreover, the laminating of many modules equipped with the function and gestalt of different species and a variety can be carried out, and various functions can be demonstrated in the one structure.
[0050] Moreover, thermal expansion is absorbable by part for the joint of an inter module with this invention. That is, shock absorbing material can be prepared in the plane of composition of an inter module one, and a module can be joined.
[0051] In the structure set to two from two or more modules, shock absorbing material is arranged in the both ends of an inter module or/and the structure, for example, in the case of the catalyst support for

automobile exhaust, canning is carried out to EGUZOSUTOPAIPU between exhaust gas outlet pipes from engine EGUZOSUTOMANIHORUDO.
[0052] Thus, although the structure which consists of a module had coated the parent of the very small cordierite of thermal expansion with the alumina with large surface area conventionally since the absorbance of a thermal shock was very large, it became possible by this invention to also use materials with a comparatively large coefficient of thermal expansion (8x10-6/degree C), such as an alumina, for the parent itself. An alumina also has the advantage that reinforcement is high and can extend the applicability to the honeycomb-like ceramic structure of the ceramic raw material which has the property which was excellent in versatility in this way by this invention.
[0053] Moreover, the laminating of each module is carried out so that a cel may penetrate to shaft orientations (free passage). The free passage hole of this penetrated cel does not need to have linear or/and the continuous cell wall which forms a hole. The structure where of the structure formed the shape of a curve, spiral, stair-like, or in the shape of JIGUZAKU or division and re-unification of a fluid, and its repetition are performed can make [many] an opportunity with the gas at the time of aeration to contact, and is desirable, and the structure whose pressure loss of a fluid decreases by the fluid which passes a cel serving as an abbreviation spiral style even when a cell wall is intermittent is also desirable, and it is the big advantage of the modularization of the structure of this invention that these can choose freely.
[0054] According to this invention, a spiral free passage hole can be easily formed by making a shaft center rotate each module little by little (changing an include angle), or making it join alternately.
[0055] moreover, the thing for which cel **** is changed little by little -- or a stair-like free passage hole can be formed by the module of the same cel cross-section configuration also shifting these modules, and carrying out two or more association.
[0056] Furthermore, a different function for every module can be given to shaft orientations as an advantage of a modularization. For example, each module which supports the optimal catalyst for business, such as particle adsorption, and HC, CO, NOX, is combinable. Since it is one apparatus conventionally, it is difficult to prepare a different coating layer after shaping in the interior of a cel, and the structure of banding together cel tubing with which functions differ in the direction of a cel cross section is also considered, but with this structure, since each cel acts only on one kind of specified substance to shaft orientations (absorption, adsorption), the engine performance will be very inferior.
[0057] Only the module for particle adsorption which is easy to get it blocked also especially for example, at the time of exchange is exchangeable with this.
[0058] According to the above-mentioned description, the honeycomb-like ceramic structure of this invention can carry out catalyst support for automobile exhaust, and cannot stop at a gasoline engine, but can also use the object for diesel power plants, and a deer for large-sized engines. Furthermore, although there are offgas treatment equipments, such as catalyst support in various chemical reactions, a bioreactor, works, and an electric power plant, a water purifier, a wastewater purge, etc. in typical applications other than the catalyst support for automobile exhaust, the application of the honeycomb-like ceramic structure of this invention is not limited to these.
[0059]
[Example]
Based on <example 1> drawing 1 , the outline of one example of the structure of the honeycomb-like ceramic structure 1 of this invention is explained. (a) is the strabism transparency Fig. of the honeycomb-like ceramic structure 1, it is the strabism transparency Fig. of a honeycomb-like ceramic disk-like module, (c) is the sectional view of the direction of c-c' of (a), and (b) shows the puncturing cel 3 and especially the cell wall 4.
[0060] That is, it is divided into a cell wall 4 and there are many puncturing cels 3 (drawing 1 (c)). Two or more (drawing five pieces) laminatings of the honeycomb-like ceramic module 2 (drawing 1 (b)) which has the puncturing cel 3 of such a cross-section configuration are carried out (drawing 1 (a)). Moreover, the laminating is carried out so that the puncturing cel 3 of each module 2 may be open for free passage.

[0061] Some manufacture approaches of the honeycomb-like ceramic module 2 of <example 2> this invention are explained. However, the module of this invention is not restricted to the manufacture approach given in this example.
[0062] One is extrusion molding. It is the approach of extruding what added and kneaded ceramic powder and a binder (plastic matter) through the dice for shaping corresponding to the cross-section configuration of a puncturing cel, and acquiring a honeycomb-like Plastic solid. The dice for shaping consists of a slit of the shape of a matrix which forms the feeding section and the Plastic solid (cel) section of the shape of a cylinder which feeds a plastic matter. By this extrusion method, the conventional catalyst support for automobile exhaust carries out crystal orientation of the cordierite, and is manufactured (illustration is omitted).
[0063] An example of the presentation (weight rate) of a cordierite base and the relation of burning temperature is shown in Table 1. In addition, these raw materials etc. are used also in other manufacture approaches.
[0064]
[Table 1]

コーディエライト素地の組成（重量割合）と焼成温度

カオリン	滑石	Al_2O_3	$MgCO_3$	$BaCO_3$	$PbSiO_3$	焼成温度（℃）	吸水率（%）
75.0	25.0			10.0	10.0	1,288	0.2
72.3	21.9		5.4			1,343	2.2
67.9	14.7		17.4			1,288	13.4
41.0	44.0	15.0				1,316	9.1
41.0	44.0	15.0		10.0		1,288	1.5
41.0	44.0	15.0			10.0	1,288	0.0

[0065] Then, an example of a ceramic raw material, the class of binder, and the relation of a weight rate is shown in Table 2. In addition, these raw materials etc. are used also in other manufacture approaches.
[0066]
[Table 2]

セラミック原料とバインダの重量割合（ｗｔ％）

セラミック原料	バインダ	その他
コーディエライト80、 アパタイト80、 アルミナ80	未加硫天然ゴム 10 未加硫スチレンゴム 10	
コーディエライト ８０～９５ アパタイト80、 アルミナ80	有機質繊維 ５～２０	
コーディエライト アパタイト アルミナ （組成は右記各組成残部）	ポリアクリル系樹脂 1～10、小麦粉 5～40、 ペクチン 0.3～10、ビオポリー 0.1～5、 キサンタンガム+ローカストビーンガム 0.2～10 メチルセルロース 0.1～10、カルボキシルメチルセルロース 0.1～10、グアーガム 0.1～10、その他寒天、カラーギナン、カゼイン、豆乳蛋白等	

[0067] If it permutes or mixes in these ceramic raw materials and straw SUTONAITO is used for them, a mechanical strength and impact strength-proof can be increased, and it will be desirable, and will be 5 - 60wt% straw SUTONAITO more preferably.
[0068] two -- calendaring (corrugated) -- it is law. By corrugated processing or embossing, they are wavelike or the thing which forms honeycomb structure about the plastic matter which adjusted plasticity by the shaping assistant by carrying out a concavo-convex sheet, being independent, or making a plate-like sheet into **** (**), and winding up to concentric circular (illustration is omitted).
[0069] Three are the pipe banding-together method as shown with ** type process drawing of drawing 2 (a). The ceramic material sheet which considers as a tube-like object 22 by extrusion molding, or has flexibility is rounded off to a tube-like object 22, more than one join together, this tube-like object is cut and calcinated with the plate-like ceramic material sheet 24 in a package lump and a puncturing cel cross section, and the honeycomb-like ceramic module 2 is formed. In addition, the structure of the honeycomb-like ceramic module 2 can be acquired without said cutting as it is.
[0070] Four include the laminating process of the ceramic material hole aperture sheet 30 as shown in ** type process drawing of drawing 2 (b). That is, it is the approach of acquiring the honeycomb structure which makes many holes in the bulk material (plate) thru/or material sheet which uses a plastic matter as a raw material with a press etc., and has a puncturing cel. Perforation is good also by laser beam machining. In addition, the honeycomb-like structure can be obtained by also being able to perforate a comparatively thick sheet-like object (a block object, plate) by once, manufacturing the sheet-like object which perforated comparatively thin sheet-like objects (ceramic paper etc.), or the hole opened beforehand by paper making etc., carrying out the laminating of those hole aperture sheets, and calcinating them.
[0071] Especially, there is a method of making a ceramic material sheet from the mixture (plastic matter etc.) which consists of a ceramic raw material and organic fiber, and manufacturing a honeycomb structure object by being made from it as the suitable manufacture approach.
[0072] For example, the shape-ization of a sheet of the mixture which contains the plastic matter or ceramic, and binder containing a ceramic by the usual others and wet paper-making method, a doctor blade method, or the pressing method can be performed. [method / as shown in drawing 2 (c) / rolling]
[0073] In the rolling method as shown in drawing 2 (c), the mixture 20 and the organic sheet 21 of a

ceramic and a binder are compressed with a pressure roll 25, desiccation shaping is further carried out with a heating roller 26, and the ceramic material sheet 24 can be manufactured. [the sheet] [the shape of a sheet]

[0074] Moreover, mixture of organic fiber and a ceramic raw material can be bulk-ized with wet or a dry type press, and the honeycomb structure which performs press-die omission as a thick sheet-like object (letter object of a block), and has a puncturing cel can also be acquired (illustration is omitted).

[0075] The ceramic material sheet obtained by such approach is excellent in flexibility and gestalt holding power, and is a ceramic sheet which is the example of the one manufacture approach of the honeycomb-like ceramic module of this invention and which was suitable as a raw material used by the four above-mentioned approaches.

[0076] The class of a ceramic raw material and organic fiber and an example of a weight ratio are shown in Table 3. In addition, especially if an alumina is contained, the structure of high intensity can be manufactured. These serve as various ceramic material sheets and a manufacture raw material of the ceramic structure.

[0077]

[Table 3]

ハニカム状セラミック構造体の原料

	セラミック原料（坏土） セラミック成分中の重量比				有機質繊維（パルプ質） 重量比
強度／	アルミナ	珪石	長石	粘土類	マニラ麻、古紙
高強度	３０	０	３０	４０	坏土9.5に対し 0.5
	15 ～45	０	５～	40～50	坏土9.5に対し 0.5
一般強度	０	３０	３０	４０	坏土９に対し 0.5～2
その他	コーディエライト、チタン酸アルミ、ムライト、スデアタイト、リチア系低熱膨張磁器、陶磁器坏土、モルデナイト等のゼオライト鉱物、アパタイト、ワラストナイト及びその他のケイ酸カルシウムあるいはケイ酸マグネシウム				坏土９に対し 0.5～2

[0078] Like the case of Table 2, it sets to Table 3, if it permutes or mixes in these ceramic raw materials and straw SUTONAITO is used for them, a mechanical strength and impact strength-proof can be increased, and it is desirable here, and is 5 - 60wt% straw SUTONAITO more preferably.

[0079] In case the honeycomb structure object manufactured from organic fiber and a ceramic raw material forms the honeycomb structure before baking, it fits especially manufacture of the honeycomb structure object which is excellent in flexibility and gestalt holding power with the support force over the ceramic particle (powder) of organic fiber, and has a complicated cel configuration.

[0080] Moreover, organic fiber is burned down after baking, the parent of the quality of a ceramic serves as porosity, surface area especially increases, and it is desirable as catalyst support.

[0081] In addition, the honeycomb-like ceramic structure manufactured by the above approach is calcinated, and turns into a porosity sintered compact. Burning temperature changes with the quality of the material and applications. For example, the various baking conditions in the case of cordierite are as already having been shown in Table 1.
[0082] An example of the ceramic raw material used as the use raw material of the manufacture approach concerning the above honeycomb-like ceramic module (structure) and a binder (organic fiber is included) is shown in Table 4.
[0083]
[Table 4]

種々のセラミック素材シートの原料

セラミック原料（坏土）	バインダ
滑石、蛙目粘土、カオリン、アルミナ、珪石、長石、粘土、解膠剤（水ガラス等） アパタイト、コーディエライト、チタン酸アルミ、リチア系低熱膨張磁器あるいは陶器坏土、ムライト、ステアタイト、モルデナイト等のゼオライト、ワラストナイト、パイロフェライト	有機質繊維（パルプ質）： （天然）マニラ麻、苘麻、木綿、絹、パルプ （人工） ナイロン、ビニロン、ポリエステル、人絹、アクリル 古紙、不織布 その他：天然ゴム、スチレンゴム、ポリビニルアルコール
金属粉末、 h－BN	

[0084] An example of a new-ceramic raw material is shown in Table 5. It can become the ingredient of the module (structure) which this new ceramic also requires for this invention. Moreover, although organic fiber was used as some raw materials of the above-mentioned ceramic material sheet, an inorganic fiber also serves as a raw material of the structure of this invention, it can mix with organic fiber and only an inorganic fiber can be used as a raw material. If an inorganic fiber (ceramic fiber) is used especially, since this is not burned down at the time of baking, it becomes modular (structure) toughness strengthening and is desirable.
[0085]
[Table 5]

ニューセラミック

坏土	繊維
酸化物系：アルミナ、コージライト、ジルコニア、マグネシア、ケイ酸塩、アパタイト 非酸化物系：炭素、炭化ケイ素、窒化アルミ、窒化チタン、窒化珪素、h－BN	ジルコニア繊維、チタン酸カリウム繊維、炭素繊維、アルミナシリケート繊維、シリカ・アルミナ・ジルコニア繊維、ガラス長繊維、ガラス短繊維、アルミナ繊維、ムライト繊維、ワラストナイト繊維、ケイ酸カルシウム繊維
金属粉末	ウイスカ：Al－SiC ：Si3N4－SiC ：Al2O3－SiC ：ZrO2－SiC
上記の他の金属酸化物及び／又は金属窒化物	

[0086] In addition, the raw material (the plastic matter, binders (organic fiber etc.)) and the so-called new-ceramic raw materials of the ceramic material sheet illustrated to Table 4 and 5 (a plastic matter, ceramic fiber, etc.) are prepared by various presentations according to the purpose and an application.
[0087] Furthermore, a honeycomb-like ceramic module (structure) may be covered with the slurry which contains a ceramic component before baking (spraying spreading, immersion, etc.). This can adjust porosity and specific surface area. Moreover, after baking, it may cover with the above-mentioned slurry, you may calcinate further, and reinforcement increases comparatively. It will become high intensity if it covers and calcinates by the slurry which contains an alumina component especially.
[0088] How to carry out two or more laminatings and to manufacture the honeycomb-like ceramic structure 1 is explained so that the puncturing cel 3 may open the <example 3> honeycomb-like ceramic module 2 for free passage. In addition, in this example, the configuration of a module 2 is a disk-like object (plate) with a circular cross section. But, it is not restricted to this. A cross-section configuration has polygons, such as a square, five square shapes, and six square shapes, an ellipse, a semicircle, an approximate circle form like fanning, an indeterminate form, etc.
[0089] Many things are considered about the method of junction of an inter module. In one, it is a mechanical assembly (it fits in in an outer case and thermal expansion and vibration are absorbed through elastic material if needed.).
[0090] The module 2 by which two weld the periphery section of a module 2 for every module, or welds only a part and joining is not carried out is pinched or fitted in with other modules or outer cases by which low attachment was carried out.
[0091] Three apply to the field of the cel aperture of the cel frame 4 of each module the paste of the silicon oxide which is sintering acid, an oxidization yttrium, titanium oxide, etc., and both modules are joined.
[0092] Moreover, it is also desirable as joint material to insert thermal stress absorption insertion material into an inter module. For example, they are Fe-nickel-Cr, covar, etc.
[0093] Four are the approach of inserting a rod-like structure (tube-like object) which penetrates and holds each module to at least one of the puncturing cels 3 open for free passage.
[0094] Five are the approach of preparing a tenon which fits in mutually in each module, and joining to it mechanically. In the phase before modular sintering (it has plasticity), such a tenon can be prepared easily. In addition, the above-mentioned joint material may be used together as a nominal member.
[0095] In addition, although the laminating of the module 2 of the same die length (shaft orientations of a puncturing cel), the diameter of said, and this puncturing cel is carried out in drawing 1 , the laminating of the module of different die length, a path, and a puncturing cel may be carried out.

Moreover, the laminating of the module of the shape of a doughnut in the air may be carried out.
[0096] <Example 4> The three-dimensional structure of the puncturing cel 3 open for free passage is explained. since the laminating of the module 2 of same class is carried out by whenever [same axle and isogonism] in drawing 1 -- a puncturing cel -- the shaft orientations of a puncturing cel -- being linear (prismatic form) -- it is formed.
[0097] drawing 3 -- the strabism fragmentary sectional view of the honeycomb-like ceramic structure 1 -- it is -- (a) -- stair-like (stair-like puncturing cel 7) and (b) -- being spiral (spiral puncturing cel 8) -- the three-dimensional structure of the formed puncturing cel 3 is shown.
[0098] In addition, in (a), although the level difference in the expedient upper contiguity module of a drawing is expanded and exaggerated, in being thin, one another modular cel will flow in two or more cels of a contiguity module, as a cell wall is illustration.
[0099] thus, the three-dimensional structure of the puncturing cel 3 -- abbreviation -- being spiral (stair-like 7 or the spiral puncturing cel 8) -- it can form. In case the approach combines the honeycomb-like ceramic isomorphism-like (outer-diameter, puncturing cel configuration) module 2 in the spiral puncturing cel 8, **** rotation (forward reverse both directions) of the core is carried out for a while on the same axle. Therefore, an outer diameter is in the condition which was put together, and the internal puncturing cel 3 is open for free passage spiral, rotating. For this reason, the volume of the structure 1 whole increases the contact nature of surface area thru/or a passage fluid, without changing, for example, in the case of catalyst support, the reaction effectiveness over the passage fluid of the fixed volume rises. If a fluid carries out RASEN rotation, in connection with it, turbulence will arise with flow, and, as for the passage style in a cel, the contacting efficiency to a cell wall will increase compared with an parallel straight-line style.
[0100] moreover, stair-like -- it is -- carrying out -- the puncturing cel 7 of an in-a-completely-different-class include-angle gap array -- setting -- the puncturing cel 3 -- a few -- ********** -- the puncturing cel 7 which carries out the laminating of the module 2 like, and is open for free passage stair-like like drawing 3 (a) can be formed.
[0101] In addition, this stair-like structure is the increment approach of surface area that the cross section was suitable for the square honeycomb-like ceramic module 2. As for the spiral puncturing cel 8, the appearance is especially suitable in the cylinder-like module 2.
[0102] Drawing 4 shows typically the cell wall 4 of the tabular module 2 by which shifted the phase of a puncturing cel in the honeycomb-like ceramic structure 1, and the laminating was carried out, (a) is the top view of a cel puncturing side, (b) is a side elevation and the arrow head shows a part of flow of a fluid typically. A continuous line shows the 1st step of all cell wall 4a, and cell wall 4b of the 2nd step of module has put in the break on account of illustration at the point (point which lap and is in sight) which intersects 4a in three dimensions. In addition, P1 and P2 show puncturing [the 1st step and the 2nd step of] cel pitch, respectively.
[0103] Drawing 5 is the top view of the cel puncturing side of the honeycomb-like ceramic structure 1, some cell walls of the module of the shape of a disk disk by which shifted the phase of the puncturing cel 4 and the laminating was carried out are shown, and, in (a), the module with which puncturing cel cross-section configurations differ, and (b) carry out the laminating of the module with the same puncturing cel cross-section configuration, respectively. A continuous line shows the 1st step of all cell wall 4a, and the dotted line shows cell wall 4b of the 2nd step of module. Puncturing [the 1st step and the 2nd step of] cel pitch is shifted to radial and a circumferencial direction the half pitch every, respectively. In addition, a sign 5 is a structure (module) outer wall, and a sign 6 is a structure (module) green sand core. They are the temperature of the fluid which passes the puncturing cel in the direction of a cross section by the green sand core 6, and the structure whose homogeneity of a component increases.

[0104] Like drawing 4 and the honeycomb-like ceramic structure 1 of drawing 5 , if it shifts to every direction, or a radius and a circumferencial direction a puncturing cel half pitch every, respectively and a laminating is carried out to it The fluid which passed through the core of a puncturing cel by the 1st step of module contacts in the 2nd step at the lattice point of a cell wall (3, the 4th step is the same), and a

contact opportunity with the cell wall 4 of a fluid increases, and moreover, so that clearly [in drawing 4 (b)] Since the cross section of the fluid channel for every module does not change, there is little pressure loss of a fluid.

[0105] Thus, the cell wall surrounding a fluid channel, i.e., a puncturing cel open for free passage, can make not continuation but the fluid which passes a puncturing cel an abbreviation spiral style, even if intermittent.

[0106] Moreover, mixing of a fluid which passed through the module periphery section and a core takes place, and temperature and a component become homogeneity. Such structure is suitable for chemical reaction equipments, such as catalyst support, especially the catalyst support for exhaust gas removal.

[0107] moreover, the abbreviation from the module same by rotating the core of said cross section for a module with the same puncturing cel cross-section configuration as shown in drawing 5 (b) as a shaft -- a spiral fluid channel can be formed. However, module die length, the quality of the material, etc. of puncturing cel shaft orientations may differ from each other.

[0108] By the way, a cell wall (frame) 4 cannot receive destruction by self-weight easily by being manufactured for every (every element) module. Moreover, it is hard to produce destruction by the ununiformity of thermal expansion also at the time of sintering. For example, since extrusion molding can also make a cell wall thin and can raise whenever [cel] like cell wall thickness 0.2mmt (possible up to about 0.1 to 0.3 mmt), and 1.2mm [of puncturing cel angles] **, the surface area in a puncturing cel has the effectiveness of increasing with the grand total.

[0109] <Example 5> In using the honeycomb-like ceramic structure 1 as catalyst support especially, in order to aim at improvement in specific surface area and the catalyst support force, alumina coatings (gamma-alumina etc.) may be carried out to puncturing cel 3 wall.

[0110] After slurry covering (immersion, blasting, etc.), an alumina coating layer (exaggerated coat) can be burned at predetermined temperature, and is performed, and adhesion of a support catalyst is possible for it in endocyst thru/or the form where it adsorbed, in the coating layer itself, such as formation of a catalyst bed thru/or an alumina. as an example -- catalyst beds (noble metals, base metal, etc.) -- honeycomb-like ceramic structure 1 base -- or it is preferably formed on the above-mentioned alumina coating layer of CVD, active metal solder, and solid phase (or liquid phase) diffused junction.

[0111] as that to which especially surface area increases and chemical reaction effectiveness rises -- a honeycomb-like ceramic structure base -- a gamma-alumina coating layer -- forming -- a catalyst 10 -- support . ****. In addition, there is no catalyst 10 as an independent layer of a catalyst, and trespasses upon the particle clearance between porosity alumina coating layers, and is making the surface layer of an alumina layer in many cases.

[0112] <Example 6> this example explains the honeycomb-like ceramic structure 1 from which a function differs every module 2 and which made the catalyst support.

[0113] The class of noble-metals system catalyst, an application, and an example of support are shown in Table 6.

[0114]

[Table 6]

貴金属系触媒機能

種類	機能	担体
Ｐｔ－Ｒｈ系	三元触媒 ＮＯＸ還元、ＣＯ酸化ＨＣ酸化	アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ
Ｐｔ－Ｐｄ系	ＣＯ酸化、ＨＣ酸化	アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ
Ｒｕ系	ＮＯＸ還元	アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ

[0115] The class of base-metal system catalyst, an application, and an example of support are shown in Table 7.
[0116]
[Table 7]

卑金属系触媒機能

種類	機能	担体
Mn－Ce	NO還元 C除去	アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ
Mn5％	脱臭	
Co5％－(Mn－Ce)-1～60％－Ca		アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ
La、Sr、Ca、Ce、Zn、Cu、Nd、Mn、Fe、	NOX還元	アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ
Cu2O（低温）	NOX還元	アパタイト、ムライト、γアルミナ、モルデナイト等のゼオライト、コーディエライト、チタン酸アルミ

[0117] Moreover, as a polyfunctional catalyst, when R is carried out for rare earth elements and D of T (Mn, Fe, etc.) and the alkaline earth metal is carried out for a transition element (Mg, calcium, Sr, Ba, etc.), the catalyst which has the presentation of R1-XDXTO3 is also desirable without an expensive noble-metals element. In addition, it is the range of x=0.1-0.6 preferably, and is the x= 0.5 neighborhood still more preferably.

[0118] Moreover, it is also desirable to use the Cu2O catalyst acquired by doping Cu+ to a zeolite (for example, ZSM mold), and calcinating in N2 or CO ambient atmosphere with the burning temperature of about 800-1000 degrees C as a catalyst which removes NOx effectively. However, since the ZSM mold zeolite is expensive, it is also desirable to use natural mordenite in addition to this as a zeolite.

[0119] The exploded view of the honeycomb-like ceramic structure 1 which consists of suitable as example which made drawing 6 support catalyst from which above functions differ when it uses as catalyst support for automobile exhaust especially (especially for diesels) particulate (particulate matter) filter (PF) module 2a, heating element module 2b, and catalyst support module 2c etc. is shown.

[0120] Module 2a is a module which is a particulate matter filter. Alumina bases (gamma-alumina etc.), a zeolite (for example, TEKUTO aluminosilicate), etc. may be desirable materials, and a cordierite base is sufficient as the quality of the material. Or the mixed base which mixed this etc. and increased the advantage of both base is sufficient. Especially by this module, adsorption treatment of the solid-state carbide particle is carried out.

[0121] Module 2b is a heating element module and are TiC or B4 C and SiC, and the honeycomb-like ceramic structure that consists of MoSi. Moreover, the honeycomb-like structure which consists of high resistance, a metal of high thermal resistance, or an alloy is sufficient. This module can also carry out baking removal of the particle to which it generated heat by energization and the catalyst engine-performance reservation at the time after starting of a heavy load was performed and which was adsorbed by said module 2a. In addition, it is also desirable to use this module as the metal module which uses molybdenum as a principal component.
[0122] Module 2c is oxidation catalyst support, and is a Pt-Pd system catalyst as an example. It oxidizes, and CO, HC, etc. are defanged as CO2 or H2O, and are removed.
[0123] Module 2d is reduction catalyst support, and is a Mn-Ce system catalyst as an example. NO is returned and it defangs as N2. Moreover, Ru system may be used for this as an example.
[0124] Module 2e is three way component catalyst support, and is a Pt-Rh system catalyst as an example. It oxidizes, and CO, HC, etc. are set to CO2 or H2O, and NOx is returned, and it defangs as N2.
[0125] Modules 2d and 2e are further used as **** or other modules if needed. the above-mentioned case -- setting -- each module 2a, 2b, and 2c -- the need -- responding -- several [-fold / of arbitration] -- ******** -- things cannot be overemphasized. Moreover, even if an array sticks one by one, it can change if needed.
[0126] In addition, since each module 2 can change and design an arrangement location with the operating temperature and the relative location of each catalyst to support, its catalyst effectiveness improves sharply as a whole.
[0127] Moreover, according to the description (weight, a consistency, specific surface area) of a carbide particle, uptake of the carbide particle of various gestalten can all be carried out by cel puncturing 3 configuration, the cel cross-section configuration, the diameter of a cel, and changing whenever [porosity / of a ceramic body] further.
[0128] The sectional view of said honeycomb-like ceramic module 2 which is one example of this invention is shown in <example 7> drawing 7 , and module die-length L of the direction of a cross section of the puncturing cel 3 and especially module thickness T of puncturing cel shaft orientations are shown in it.
[0129] Like illustration, it is desirable for the structure of this invention to come to carry out the laminating of the module of the shape of tabular [comparatively flat] or a disk. Because, especially, since it is thin, the heat strain has also become [thickness T of puncturing cel shaft orientations / the temperature gradient of this direction] small small. Moreover, T is easy and, as for a thin thing, manufacture can manufacture the module 2 of a major diameter (L) easily. When the major axis L of the crossing direction of the puncturing cel of a honeycomb-like ceramic module can manufacture a thing 10cm or more and specifically carries out the laminating of this, the large-sized structure can be manufactured. If there is L 10cm or more, the honeycomb-like ceramic structure of this invention is suitable also for the field which needs large-sized catalyst support for exhaust gas like a diesel rolling stock.
[0130] Furthermore, it is desirable that there is thickness T 1mm or more of the shaft orientations of a puncturing cel from the reasons of manufacture, the crack of a cell wall 4 etc. decreases, and the yield improves.
[0131] If it expresses by modular thickness / major-axis ratio (T/L), it is still more desirable that T/L is 0.5 or less, and it is much more desirable that T/L is 0.25 or less. The module which has the relation of such T/L by carrying out a laminating the structure of the magnitude of arbitration It can obtain without defects, such as a crack in a production process (especially under honeycomb shaping and sintering) and a check, arising. When a thermal shock in use also absorbs an impact for every module, destruction can be prevented, and a mechanical shock can also be absorbed by the inter module, or an impact (thermal and mechanical) absorption layer (**) can also be prepared in an inter module, and impact absorptance improves further. In addition, of course, a mechanical strength, toughness, and impact strength-proof improve and are desirable [a thermal shock] by mixing an inorganic fiber as a module (structure) raw

material.
[0132] And since thermal and mechanical shock absorptance improve because T/L is 0.5 or less and further 0.25 or less, and the laminating of many modules can be carried out if the die length of the puncturing cel shaft orientations of the structure is so the same that its upper T / L is small, the function in which many differ for every module can be made to be able to bear, or an inclination function can be made to have. Moreover, the design degree of freedom of a cel free passage configuration also increases.

[0133] An example of the configuration at the time of actually using the honeycomb-like ceramic structure of <example 8> this invention for the engine system of an automobile as catalyst support is explained.
[0134] The honeycomb-like ceramic structure is fitted in the exhaust pipe (EGUZOSUTOPAIPU) which connects exhaust gas emission tubing and an engine as catalyst support.
[0135] Moreover, since the large-sized product of arbitration can be easily manufactured by the laminating and it has thermal shock resistance as applications other than automobile relation, it is suitable also for the object for a generation of electrical energy, the diesel-power-plant gas catalyst for vessels, and the catalytic-reaction equipment of a chemical processing plant. Moreover, it can be used for a bioreactor etc. Furthermore, since a catalyst function which is different to each module can be given, it is suitable also for the multistage story reactor (multistage story catalyst equipment).
[0136] <Example 9> [0137] The honeycomb-like structure of this invention can be used as a ceramic-metal composite-construction object combining a metallic material. For example, the periphery section (field) of the honeycomb-like ceramic structure can raise reinforcement and toughness as a blacking wash tubular object with the metal plate made from stainless steel. Moreover, reinforcement and toughness can be raised also by carrying out joining of the metal to a peripheral face by plating etc., and forming a sheet-like object.
[0138] Moreover, reinforcement and toughness can be raised according to the structure of holding the honeycomb-like ceramic structure in metallic conduits (a tubular object, tube-like object), such as stainless steel. Or it is good also as structure which prepares the honeycomb-like metal structure which has a cel in the periphery section (field) of the honeycomb-like ceramic structure, and raises impact absorbance more.
[0139]
[Effect of the Invention] The honeycomb-like ceramic structure of this invention is enlargeable by being made of two or more modules with a modular laminating (claims 1 and 2). moreover -- since it sinters for every module -- thin -- a **** cell wall and a complicated cel configuration can be realized easily.
[0140] Moreover, since the temperature gradient between tap holes decreases from input for every module when the puncturing cel shaft-orientations distance of each module becomes short and there is a temperature gradient at a heat flow rate or structure both ends, the thermal shock of each module decreases and can offer structure very strong against a thermal shock as the whole structure. Moreover, thermal expansion is absorbable by part for the joint of an inter module.
[0141] Moreover, by manufacturing for every module, at the time of honeycomb shaping and baking, the honeycomb-like ceramic structure in which the improvement in the yield at the time of manufacture is possible can be offered so that defective generating of poor shaping, a crack, a check, etc. may decrease.
[0142] moreover -- since it is exchangeable for every module -- a certain module -- breakage -- or even if it carries out blinding, only the module is exchangeable easily.
[0143] As mentioned above, it is strong to mechanical stress or a thermal shock, and since it has the above-mentioned advantage in a production process, the large-sized honeycomb-like ceramic structure [as / whose outer diameter of the direction of a cross section of the puncturing cel of said honeycomb-like ceramic structure is 10cm or more] is obtained. The desirable shaping approaches other than the extrusion-molding approach can be used for the outer-diameter dimension, and if it fabricates from the sheet-like object containing especially organic fiber, 30cm or more - 50cm and the thing of it which amounts to 1m or more depending on the case will also become possible. Moreover, the dimension of

the shaft orientations of a puncturing cel is made for a long time to infinity as a matter of fact (above claim 1).

[0144] Like the shape of tabular or a disk, a modular gestalt is a thin thing relatively, especially, has an advantage in the above-mentioned production process, and can incorporate various gestalten and the module of a function in the one structure (claim 2).

[0145] If it expresses by modular thickness / major-axis ratio (T/L), L will specifically be that T/L is 0.5 or less in 10cm or more. The structure of the magnitude of arbitration The crack in a production process (especially under honeycomb shaping and sintering), It can obtain without defects, such as a check, arising, and destruction can be prevented when a thermal shock in use also absorbs an impact for every module. A mechanical shock can also be absorbed by the inter module, or an impact (thermal and mechanical) absorption layer (**) can also be prepared in an inter module, and impact absorptance improves further. Since the laminating of many modules can be carried out if the die length of the puncturing cel shaft orientations of the structure is so the same that T/L is moreover small, the function in which many differ for every module can be made to be able to bear, or an inclination function can be made to have. Moreover, the design degree of freedom of a cel free passage configuration also increases. Thus, since the honeycomb-like ceramic structure of the magnitude (the direction of T) of arbitration can obtain easily by the major diameter (L), it excels especially as large-sized catalyst support as catalyst support for exhaust gas of a diesel rolling stock, the object for a generation of electrical energy, and the diesel power plant for vessels (claim 3).

[0146] For every module, in a different module configuration, for example, an outer diameter, die length, and a puncturing cel, whenever [cel], cell wall thickness, the number of cels, the spacial configuration of a cel, the quality of the material, etc. can change (the shape of a taper etc.), and a variegated function of a different kind can be demonstrated as the one structure (claim 4).

[0147]